Minnesota Phosphorus Fertilizer Law

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Nutrient Management with the Minnesota Phosphorus Fertilizer Law

Minnesota is proudly known as "the land of 10,000 lakes", and water-based recreation is an integral part of the Minnesota lifestyle. Unfortunately, the quality of many lakes in the state is poor because of excessive nutrient levels. Over 150 lakes have been designated as impaired for water recreation and included on the 303(d) list by the Minnesota Pollution Control Agency because of excess nutrients.

There are many sources of nutrients causing water quality impairments in the urban environment, including roofs, streets, driveways, parking lots, and lawns. In urban residential areas, the majority (60 to 70 percent) of the landscape is comprised of turf areas (lawns), and runoff from these areas has been found to contribute a significant portion of the phosphorus load (Bannerman et al. 1992).

Turf areas have the potential to export significant amounts of phosphorus because most Minnesota lawns have naturally high levels of phosphorus, or have high levels as a result of many years of fertilization. Soil tests done on lawns in the Twin Cities Metropolitan Area of Minneapolis and St. Paul, Minnesota (TCMA), found that approximately 75 percent of lawns had high (22 to 50 lbs/acre available P) to very high (> 50 lbs/acre available P) phosphorus concentrations and additions of phosphorus fertilizer did not improve turf growth (Barten 2005). A 1992 survey determined that despite high fertility levels, homeowners in the TCMA applied approximately six million pounds of phosphorus fertilizer annually to lawns (Creason and Runge 1992). Barten and Jahnke (1997) found that when phosphorus fertilizer was applied to lawns with high phosphorus levels, the phosphorus concentration in runoff water increased significantly.

In response to these concerns, a number of Minnesota municipalities began adopting ordinances that prohibited the application of phosphorus fertilizer to lawns unless a soil test indicted a need for this nutrient. The City of Plymouth, located approximately six miles west of Minneapolis, adopted the first fertilizer restriction in 1995. In 2002, the Minnesota legislature adopted the Minnesota Phosphorus Lawn Fertilizer Law, which initially restricted phosphorus fertilizer use in the seven-county Twin Cites metropolitan area, but which was expanded in 2004 to restrict the use of phosphorus lawn fertilizer statewide after January 1, 2005.

The initial legislation enacted in 2002 established the law's major provisions:

- With exceptions, use of phosphorus lawn fertilizer is prohibited in the seven county Twin Cities metro area (defined as the seven counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington) and restricted to three-percent P_2O_5 products in remaining Minnesota counties. This provision went into effect January 1, 2004.
- Fertilizer applied to impervious (paved) surfaces needs to be cleaned up.
- Enforcement of the law is by local units of government under their existing authority.
- Local laws regulating phosphorus fertilizer use and sale are preempted.

The legislation provided for several exceptions. For example, fertilizers containing phosphorus cannot be used on lawns and turf in Minnesota unless one of the following situations exists:

- a soil test or plant tissue test shows a need for phosphorus;
- a new lawn is being established by seeding or laying sod;
- phosphorus fertilizer is being applied on a golf course by trained staff;
- phosphorus fertilizer is being applied on farms growing sod for sale.

Effectiveness of the Minnesota Phosphorus Fertilizer Law

Two objectives of the Minnesota Phosphorus Fertilizer Law were investigated to determine the effectiveness of the legislation. The Minnesota Department of Agriculture collected data to determine changes in the availability and sales of phosphorus free fertilizer (the complete document, *Report to the Minnesota State Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law*, is available on the Minnesota Department of Agriculture Web site). Data from the report is summarized below. In addition, Three Rivers Park District monitored runoff from residential drainage to determine if use of phosphorus-free fertilizer reduced phosphorus in runoff water. These data sources were used to address several important questions regarding the effectiveness of the new fertilizer law.

Is phosphorus-free lawn fertilizer readily available to consumers?

✓ Phosphorus-free lawn fertilizer was found in 97 percent of stores surveyed.

- ✓ Phosphorus-free lawn fertilizer in pesticide blends was found in 77 percent of stores surveyed.
- ✓ Organic phosphorus-free lawn fertilizer was found in 3 percent of stores surveyed.

Consumers need ready access to phosphorus-free lawn fertilizer for the law to be effective. Between October 10 and October 16, 2006, the availability of phosphorus-free lawn fertilizer was surveyed in 87 stores across the state: 66 stores in Greater Minnesota and 21 stores in the Twin Cites metro area.

The overwhelming majority of stores (97 percent) offered phosphorus-free lawn fertilizer (Figure 1). The percentage of stores offering phosphorus-free lawn fertilizer in Greater Minnesota and in the Twin Cities metro area was nearly the same (97 percent vs. 95 percent). A majority of stores (77 percent) offered phosphorus-free lawn fertilizer in pesticide blends, such as "weed & feed" products designed to both fertilize and control lawn weeds. These products were more prevalent in the Twin Cites metro area (90 percent) than in Greater Minnesota (73 percent).

Figure 1. Store Shelf Availability of Phosphorus-free Fertilizer in 87 Minnesota Stores, October, 2006 (from Report to the Minnesota State Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law*).*

Has the law reduced phosphorus lawn fertilizer use?

- ✓ In 2006, 82 percent of lawn fertilizer used was phosphorus-free, based on weight. All of the top five lawn fertilizer products used in 2006 were phosphorus-free.
- ✓ Tons of phosphorus contained in lawn fertilizers used decreased 48 percent between 2003 and 2006.

Reducing unnecessary phosphorus lawn fertilizer use is an objective of the Minnesota Phosphorus Lawn Fertilizer Law. The ideal way to measure changes in phosphorus lawn fertilizer use is to gather information directly from end users of lawn fertilizer: homeowners, groundskeepers, etc. Unfortunately, this method was not a practical option for this study. As a substitute for a direct measure, a surrogate measure of lawn fertilizer use was developed using records of tons of specialty fertilizers distributed in the state.

Using this surrogate measure, Minnesota Department of Agriculture staff measured the amount of lawn fertilizers used in the state between 2003 and 2006 – 2003 being the year before the Minnesota Phosphorus Lawn Fertilizer Law prohibited phosphorus lawn fertilizer use in the Twin Cities metro area, and 2006 being the year after the law prohibited phosphorus lawn fertilizer use statewide. Their findings are:

- The law did not appear to reduce overall lawn fertilizer use (Figure 2).
- Between 2003 and 2006, phosphorus-free lawn fertilizer use increased from 44 percent to 82 percent of market share by weight (Figure 3).
- In 2003, only one of the top five lawn fertilizer products used were phosphorus-free; in 2005 and 2006, all of the top five lawn fertilizers used were phosphorus-free.

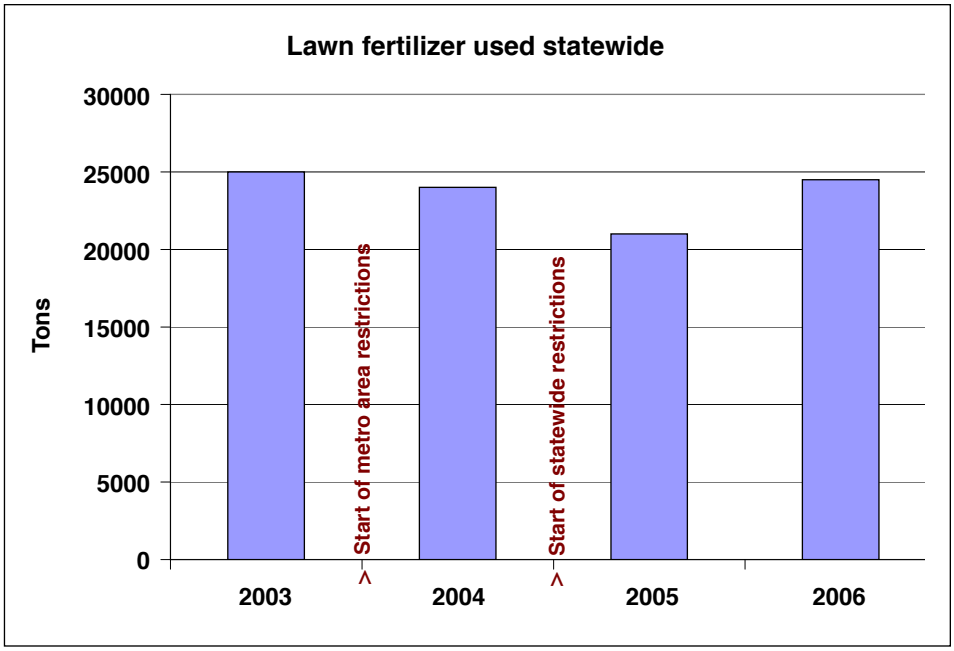

Figure 2. Tons of Lawn Fertilizer Used in Minnesota from 2003 to 2006 (from Report to the Minnesota State Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law*).*

- Total amount of phosphorus contained in lawn fertilizer used decreased 48 percent between 2003 and 2006 (Figure 4).

A substantial amount of phosphorus-free lawn fertilizer was already used in 2003, the year before the state restriction on phosphorus lawn fertilizer use went into effect. There are two likely reasons for this: (1) numerous local city ordinances in the Twin Cities metro area were already in effect requiring the use of phosphorus-free product and (2) some stores "got a jump" on providing phosphorus-free product, making it their predominate offering in 2003, the year before the state restriction.

Has the law increased costs to the consumer?

✓ Phosphorus-free lawn fertilizer costs were similar to products that contain phosphorus.

A cost comparison was made of lawn fertilizer products at two large chain stores that operate in Minnesota, Wisconsin, and North Dakota. Within store chains, similar lawn fertilizer products were compared, the only difference being Minnesota products were phosphorus-free and North Dakota and Wisconsin products contained a maintenance level of three-percent P_2O_5. Prices were the same within store chains, giving indication that consumers were not paying an increased cost for phosphorus-free product.

Has the law been enforced?

✓ No enforcements of the law were reported by local units of government.

Enforcement of the Minnesota Phosphorus Lawn Fertilizer Law was assigned by state statute to local units of government. Inquiries into instances of the law being enforced were sent to city clerks, city administrators, and stormwater managers via the League of Minnesota Cities' e-mail system. Seventeen replies were received, none of which reported an enforcement being made. Two cities reported receiving citizen complaints of the law being violated. Both cities responded to complaints by providing information on the law to the parties involved.

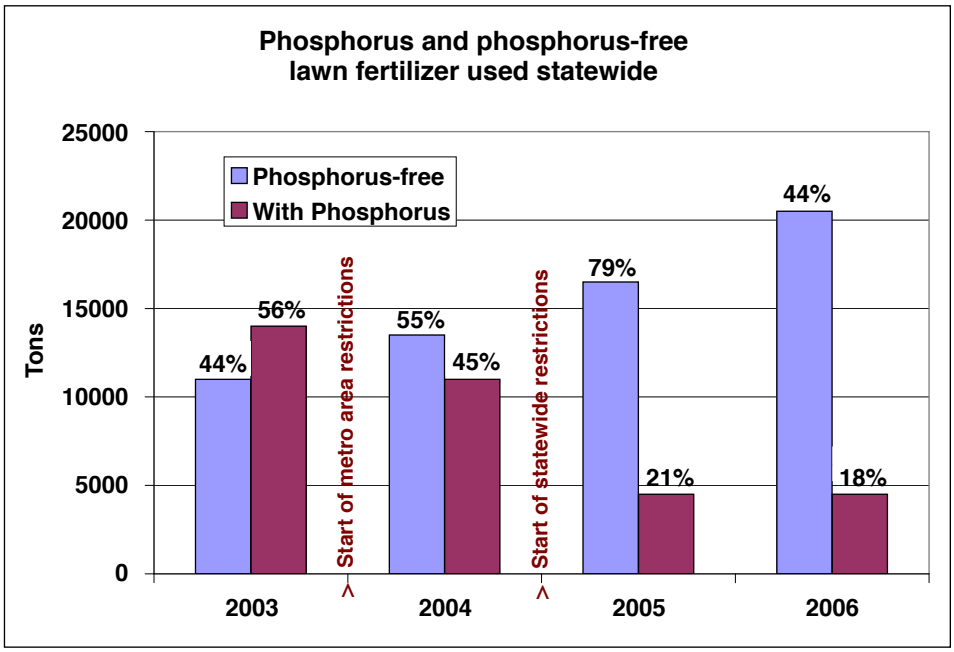

Figure 3. Phosphorus-free and Non-phosphorus-free Fertilizer Used in Minnesota, 2003 to 2006 (from Report to the Minnesota State Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law*).*

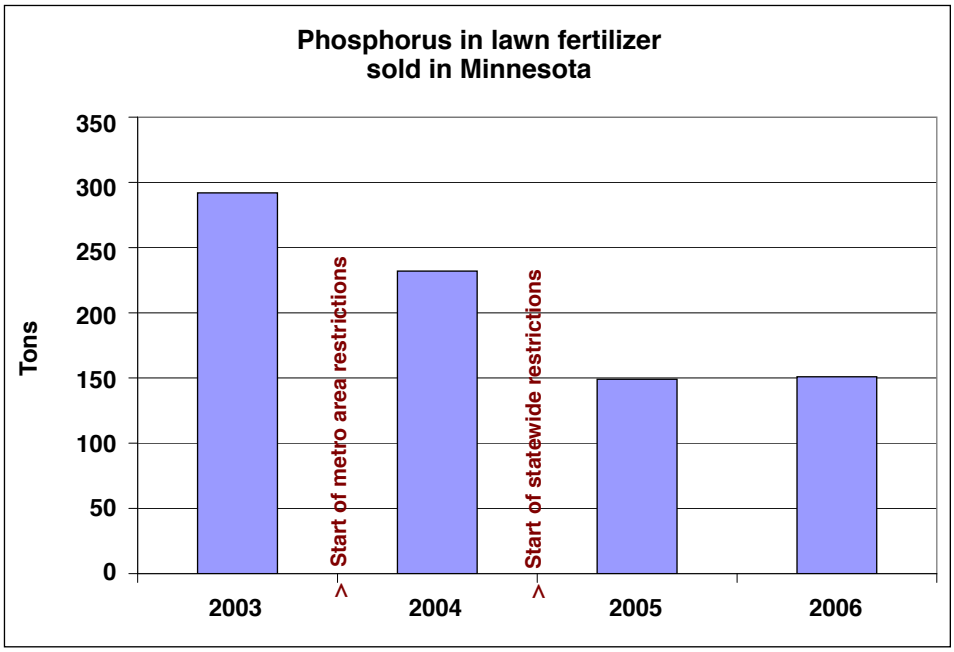

Figure 4. Tons of Phosphorus Sold as Lawn Fertilizer in Minnesota, 2003 to 2006 (from Report to the Minnesota State Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law*).*

How have consumers responded to the law?

✓ Based on interviews with retail store staff, customers are very supportive of the law.

✓ Consumers sought guidance on proper disposal of surplus phosphorus lawn fertilizer.

According to store staff interviewed during the October 2006 store survey, customer response to the law is very supportive. Ninety-seven percent (97 percent) of store staff reported customers were supportive of the law. Only three percent of store staff reported instances where customers did not buy product because phosphorus lawn fertilizer was not available.

How has the law impacted lawn fertilizer retailers?

- ✓ Stores report no problem in stocking phosphorus-free product in general, some problem in stocking specific products.

All 87 stores surveyed during October 2006 reported that they could obtain phosphorus-free product, although 14 percent said they could not find phosphorus-free product in a certain brand or for a certain application (e.g., "winterizer"). The experiences of stores in Greater Minnesota and the Twin Cities metro area were similar.

Has the law improved water quality in Minnesota?

As intended, enactment of the Minnesota Phosphorus Fertilizer Law reduced the use of phosphorus fertilizer in the state. To determine if restricting the use of phosphorus containing lawn fertilizers could reduce the phosphorus concentration and load in urban residential storm water runoff, six small residential sub-watersheds were monitored from 2001 to 2006. Three of the sub-watersheds were located in the city of Plymouth, Minnesota, where the use of fertilizer that contained phosphorus has been restricted since 1999; the remaining three sub-watersheds were located in the adjacent city of Maple Grove where restrictions were not initiated until adoption of the Minnesota Phosphorus Lawn Fertilizer Law in 2004 (Figure 5). These sub-watersheds were carefully selected to include one newly developed area, one middle-aged and one older neighborhood within each of the cities. The sub-watersheds were located within ten kilometers of each other to minimize differences in precipitation patterns, soil types, and aerial loading of phosphorus.

Additional information about each sub-watershed was collected to assess the potential role of other variables in leading to any observed differences in nutrient loading between Maple Grove and Plymouth. This included measuring the amount of impervious area in each sub-watershed, determining lawn-care practices, and measuring soil characteristics. Impervious area was determined through the use of aerial photography and desktop geographic

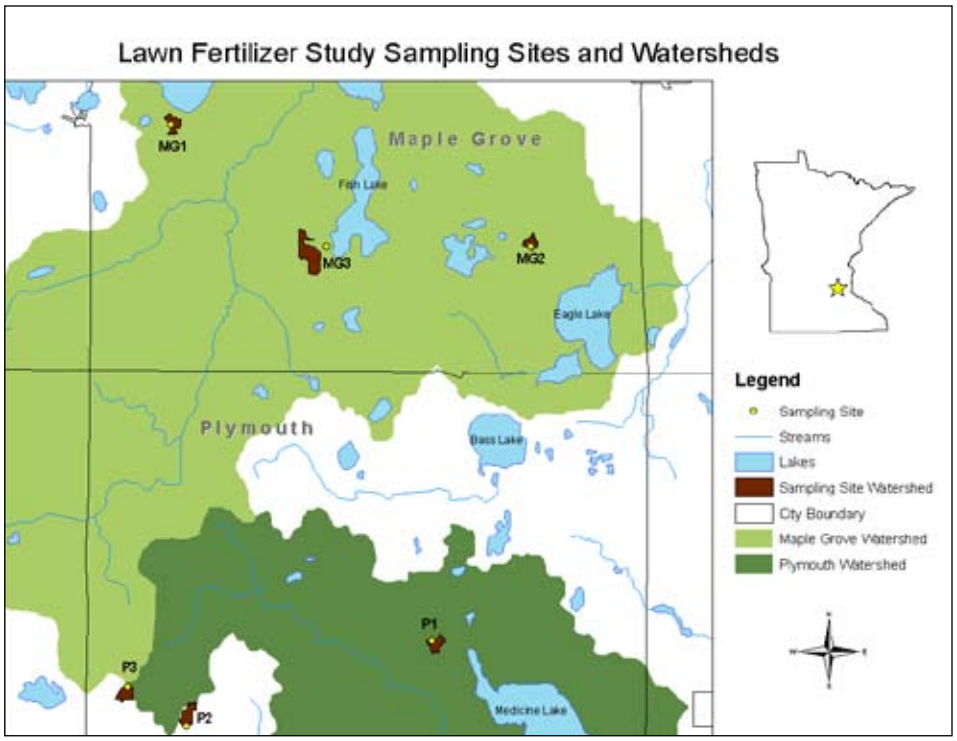

Figure 5. Map Showing the Relative Location of the Study Sub-watersheds in Plymouth and Maple Grove, Minnesota.

information system software. During a previous study, public surveys were administered to a portion of the homeowners by local high school students to characterize lawn-care practices including fertilizer application, watering, mowing, and soil aeration. Soil characteristics were determined through physical sample collection at ten percent of lawns within the sub-watersheds. These samples were analyzed for nutrient levels, organic matter, particle size, pH, and soil compaction. Overall, these additional sources of information showed that soil conditions, impervious area, and lawn-care practices were very similar, with the exception of fertilizer use. As expected, phosphorus fertilizer use in Plymouth was significantly lower than in Maple Grove.

Runoff samples and flow data were collected from approximately 670 runoff events during the monitoring period, equally distributed among the six sites. Results from the residential sub-watershed monitoring showed that a substantial amount of rain ran off of lawns, predominantly for rain event totals greater than two centimeters (2 cm) (Figure 6). The data showed that the first two centimeters of rainfall that fell on pervious areas soaked in; nearly all of the runoff observed during small rain events could be accounted for by estimating runoff from impervious areas such as streets, driveways, and rooftops. For rain events greater than two centimeters, observed runoff volumes were greater than what could be accounted for by estimating impervious runoff alone. This suggested that for rain events greater than two centimeters, runoff from pervious areas like lawns was occurring. All six sub-watershed sites showed a similar pattern.

There were significant differences ($p<0.05$) in the total phosphorus, soluble reactive phosphorus, and total suspended solids concentration in runoff from rainfall events greater and less than two centimeters across all six sub-watersheds, (Figure 7). The total phosphorus and total suspended solids concentrations were higher in runoff from events with less than two centimeters of rainfall, but the SRP concentration was higher in events greater than two centimeters. This suggests that the majority of particulate phosphorus is derived from impervious surface runoff (streets, driveways and rooftops), but the majority of soluble phosphorus originated from turf areas. The soluble phosphorus in fertilizer is a potential source of the SRP from pervious surface areas.

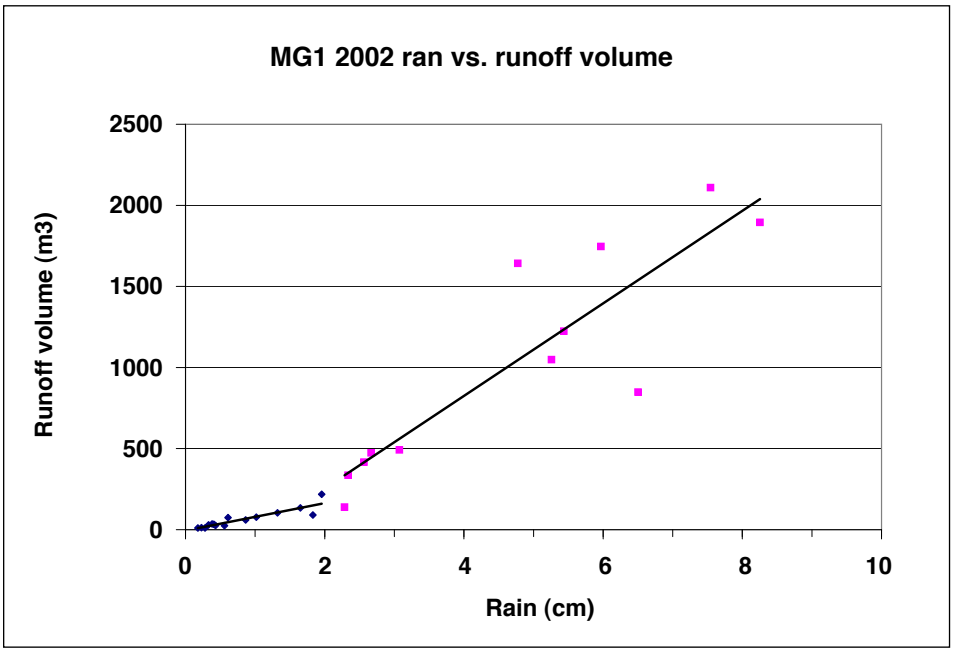

Figure 6. Relationship Between Rainfall and Runoff Volume for Site MG1 in Maple Grove Minnesota 2001 to 2003.

There was no significant difference in the event mean total phosphorus concentration between the two municipalities over the six-year monitoring period (Figure 8). However, the event mean soluble reactive phosphorus concentration in runoff from the three P-free fertilizer Plymouth sites, 111 ug/L, was significantly lower ($p<0.05$) than the concentration in the three Maple Grove sites, 136 ug/L. Conversely, the total suspended solids concentration was significantly higher ($p<0.05$) in the Plymouth sites, 110 mg/L, than the Maple Grove sites, 70 mg/L. This was surprising because high phosphorus concentrations in runoff water are typically correlated with high suspended solids concentrations. For this study, there was actually an inverse relationship between soluble reactive phosphorus and suspended solids concentrations. This suggests a phosphorus source not associated with particulate material. Soluble fertilizer runoff would be one obvious sources of this phosphorus. It should be noted that Maple Grove swept their streets more than twice as often as Plymouth, which may account for some of the difference in the suspended solids concentrations between the two municipalities. Of particular interest is that Maple Grove routinely swept streets during the fall leaf-drop period while Plymouth did not.

There was a significant amount of variability in the event mean concentrations for all parameters during the study period. Total phosphorus concentrations, for instance, ranged from 56 to 1516 μg/L. In addition, rainfall was not evenly distribution over the study area for most events, and runoff volume, therefore, also varied. To normalize the rainfall/runoff volume data and account for the concentration variability, the phosphorus export/unit area/unit runoff (g/ha/cm) was calculated for each of the six sub-watersheds. The results of these calculations were used to examine possible differences in phosphorus runoff between the two municipalities. As shown in Table 1, total and soluble phosphorus export from Maple Grove (phosphorus fertilizer used) and Plymouth (P-free fertilizer used) were similar for small rain events (< 2 cm) when the majority of runoff was from impervious surfaces. The lack of any difference in phosphorus export between the two municipalities was not unexpected since the Plymouth fertilizer restriction would not affect runoff quality from roofs, streets and driveways (unless phosphorus fertilizer was spilled on these surfaces).

Export of both total and soluble phosphorus was significantly greater ($p<0.05$) from the Maple Grove (P-fertilizer used) sites than phosphorus export from Plymouth sites for rainfall events over two centimeters when a large portion of runoff was from pervious surfaces. Applying these expected event export values to all recorded rain events from 2000-2005, yields an estimated reduction of between 12 and 16 percent from areas where phosphorus-free fertilizer was used. This suggests that the Minnesota Phosphorus Lawn Fertilizer

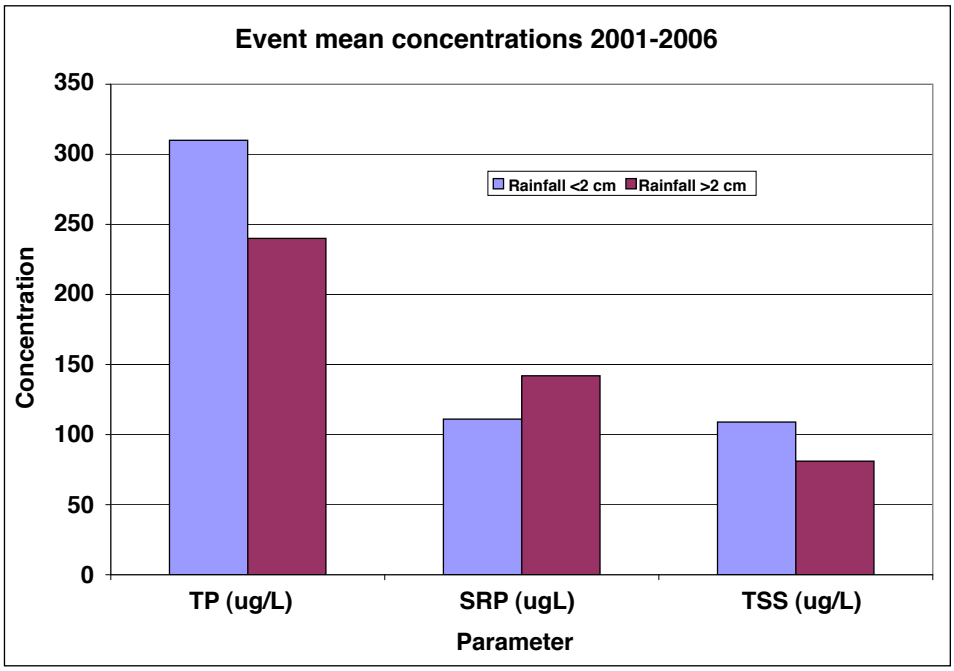

Figure 7. Mean Concentrations of Selected Parameters in Runoff from Small (<2 cm) and Large (>2 cm) Rainfall Events in Six Sub-watersheds in Plymouth and Maple Grove from 2001 to 2006.

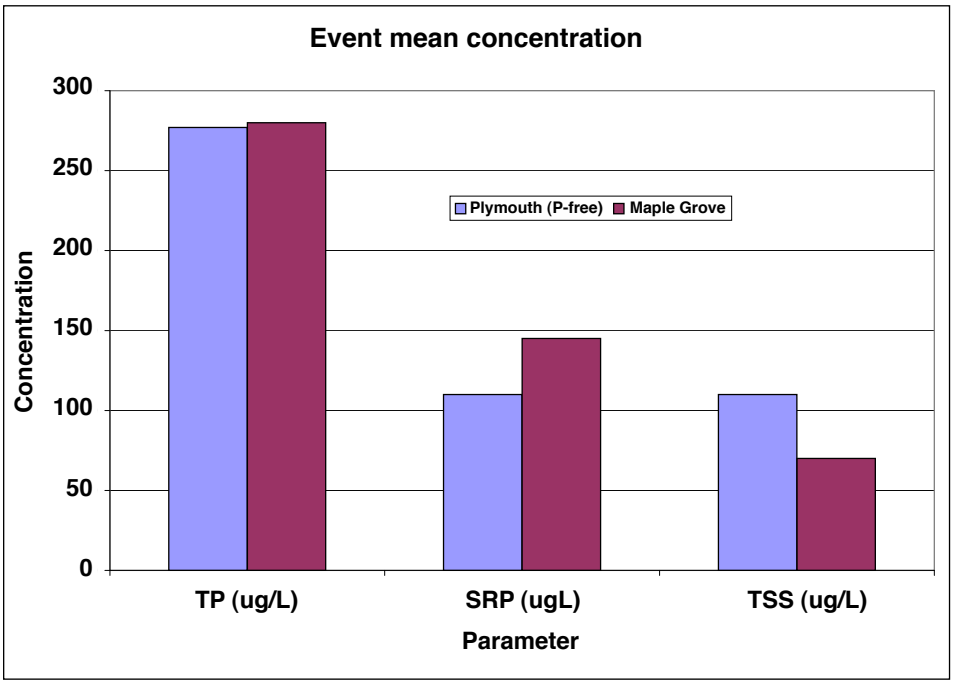

Figure 8. Event Mean Concentrations of Selected Parameters in Runoff from Plymouth, MN (P-free Fertilizer) and Maple Grove, MN (P Fertilizer Used), 2001 to 2006.

Law accomplished the objective of reducing phosphorus loading to aquatic resources in the state. Continued long term monitoring of lakes will be necessary to determine if these reductions result in improved in-lake water quality.

Summary

The Minnesota Phosphorus Fertilizer Law accomplished the objective of reducing unnecessary phosphorus fertilizer applications to lawns in the state. Approximately 82 percent of fertilizer use in Minnesota in 2006, two year after adoption of the legislation was phosphorus-free. The legislation did not cause any difficulties for retail fertilizer outlets.

Preliminary data suggest that use of phosphorus-free fertilizer can reduce phosphorus export from residential areas by 12 to 16 percent. This is a financially significant reduction because typical storm water BMP construction costs approximately $500/pound of phosphorus removed. The cost of implementing fertilizer restrictions in Minnesota has been negligible for most communities. These results have provided credibility to the idea that legislation restricting the use of phosphorus lawn fertilizers can reduce the application of phosphorus to urban turf areas, and reduce the phosphorus loading to water resources for minimal cost.

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Table 1. Unit Area Phosphorus Export (g/ha/cm) from Phosphorus Fertilized and Non-fertilized Lawns, 2001 to 2003.

	TP (g/ha/cm)		SRP (g/ha/cm)	
	Rainfall < 2cm	Rainfall > 2cm	Rainfall < 2cm	Rainfall > 2cm
Maple Grove (P fertilizer used)	33.2 ± 15.9	23.1 ± 3.2	11.3 ± 7.4	15.2 ± 2.8
Plymouth (P-free fertilizer)	35.9 ± 7.9	18.7 ± 2.3	12.5 ± 3.8	7.9 ± 1.9

For the past 15 years **John Barten** has been employed as the Water Resources Manager for Three Rivers Park District, where he works with municipalities and WMOs to mitigate the impacts of development on the quality of lakes in the Park system. John is responsible for the management of 20 lakes, 9 swimming beaches, and 56 water supply wells, and is involved in research on the quality of runoff water from lawns and golf courses.

Over the past 12 years, **James Johnson** has worked on a wide range of water-resources projects for the Wisconsin DNR–Bureau of Research, Minneapolis Park and Recreation Board, and Three Rivers Park District. His research and management interests deal predominantly with stormwater runoff monitoring, watershed model development, and aquatic plant management. James is currently a graduate student and research assistant in the water resources science program at the University of Minnesota – Twin Cities.